Rutherford ELECTRONICS CO.

INSTRUCTION MANUAL

MODEL B14

MODEL B14R

WARRANTY

The RUTHERFORD ELECTRONICS CO. warrants to the original purchaser for a period of one (1) year, EXCEPT electron tubes and semiconductors which are warranted for ninety (90) days, after date of delivery that this instrument is free of defects in material and workmanship under normal use and service. Our liability is limited to repair or replacement of this instrument or defective parts, providing failure is not due to misuse, negligence, or accident.

In order to receive service under this warranty, promptly advise the factory of all details pertinent to failure of the instrument. Defective parts or instruments should be returned to the factory, shipment prepaid, for examination by the manufacturer to determine whether it is defective. The parts or units will be replaced or repaired and returned to the purchaser via surface transportation, freight prepaid.

Instruments on which the warranty does not apply or has expired will be repaired and billed to the purchaser on a parts and labor basis.

This warranty applies to used instruments for a ninety (90) day period. Warranty also applies to repairs to the extent of the repair only, for a period of thirty (30) days.

This warranty supersedes previous warranties and is expressly in lieu of any other warranties, expressed or implied, and the RUTHERFORD ELECTRONICS CO. neither assumes or authorizes any other person to assume for it any liability in connection with the instrument which is the subject of this warranty.

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Rutherford

ELECTRONICS CO.

MODEL B14/B14R

SER. NO. 368

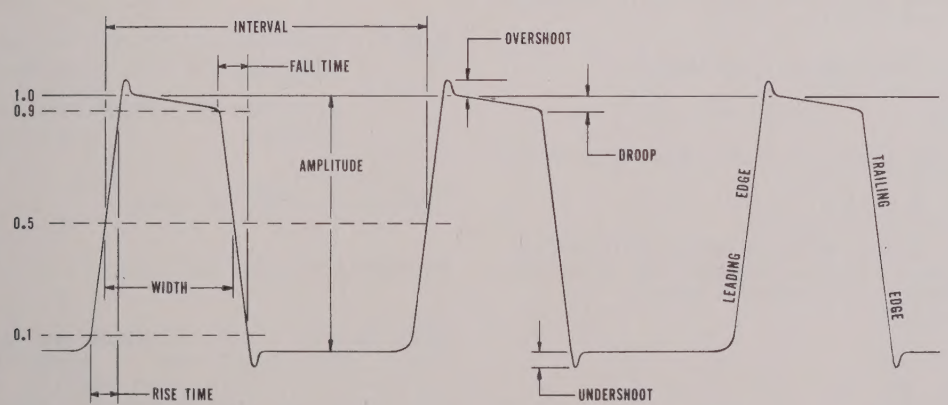


FIG. A: PULSE DEFINITIONS

IT IS UNDERSTOOD THAT ALL REFERENCES TO PULSE TERMINOLOGY IN THIS MANUAL ARE AS DEFINED ABOVE

SPECIFICATIONS

The following are the specifications of the model B14 and/or B14R.

It is understood that the main output pulse characteristics are as measured at the output jack, J3, when it is properly terminated and properly grounded to the measuring instrument.

REPETITION RATE

The repetition rate specification for the main pulse and the sync pulse is as follows.

INTERNAL OSCILLATOR MODE

In the internal oscillator mode, the repetition rate is continuously variable from 20 pulses per second to 2 million pulses per second in five overlapping ranges.

EXTERNAL TRIGGER MODE

The unit may be triggered from an external source by a waveform which exhibits the following characteristics.

Amplitude - 2 to 10 volts, peak

Repetition Rate - Single shot to 2 mc

Rise Time - 1μsec, or less

Polarity - Positive

Output Delay - A minimum delay of approximately 0.2μsec occurs between the external trigger and the main output pulse.

PULSE DELAY

The main output pulse is continuously variable in time delay (with respect to the sync pulse out) from 0.0 to 10,000μsec in five overlapping ranges.

PULSE WIDTH

The main output pulse is continuously variable in pulse width from 0.06 to 10,000μsec in five overlapping ranges.

MAIN OUTPUT PULSE CHARACTERISTICS

The main output pulse exhibits the following characteristics.

AMPLITUDE - A) Continuously variable from 0 to 15 volts, peak, into a 1,000Ω resistive load.

B) Continuously variable from 0 to 8 volts, peak, into a 50Ω resistive load.

C) Continuously variable from 0 to 2.8 volts, peak, into a 10Ω resistive load.

POLARITY - Positive or negative, but not simultaneously.

RISE TIME - 10 nanoseconds, maximum.

FALL TIME - 10 nanoseconds, maximum.

DROOP - 0.06 to 1,000μsec pulse width - negligible.

1,000 to 10,000μsec pulse width - 10%, maximum.

OVERSHOOT - 5%, or less.

UNDERSHOOT - 5%, or less.

DUTY FACTOR - 30%, maximum, at full output amplitude. Automatic protection circuitry enables operation to approximately 80% at reduced amplitude without injury to the generator.

SYNC PULSE OUTPUT

A sync pulse is available at the front panel jack which exhibits the following characteristics.

AMPLITUDE - 6 volts, peak, min., into 1,000Ω.

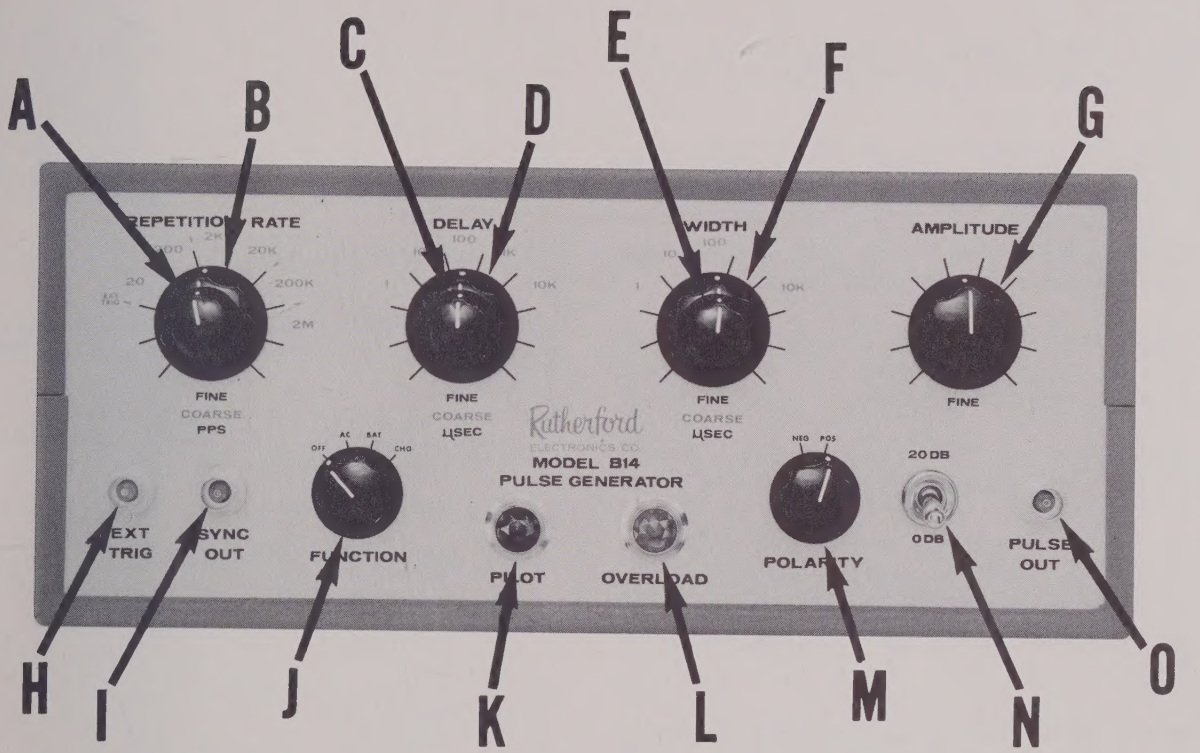


FIG. B: OPERATING CONTROLS

WIDTH - 0.08μsec, or wider.

RISE TIME - 0.05μsec, approximately.

POLARITY - Positive.

MISCELLANEOUS

DIMENSIONS - Portable, B14 - 12" wide, 5" high, 11½" deep.

Rack Mount, B14R - 19" wide, 5¼" high, 11½" deep.

WEIGHT - Net - approximately 14 lbs. (18 lbs with batteries)

Shipping - approximately 17 lbs. (21 lbs with batteries)

POWER REQUIRED - AC - 105 to 125 volts, 50-60 cps, 15 watts, max.

Battery - 18.75 volts. Battery charger is built into all instruments. Rechargeable battery pack is available which will operate the unit for approximately 8 hours at 30% duty factor.

OPERATING INSTRUCTIONS

FRONT PANEL CONTROLS

Refer to Fig. B, above, for the location of the following front panel controls.

A REPETITION RATE RANGE SWITCH - Rotary switch, S1, selects "external trigger" operation or any range of internal oscillator operation.

B FINE REPETITION RATE CONTROL - Potentiometer, R4, is the vernier control of repetition rate through each of the internal oscillator ranges.

C DELAY RANGE SWITCH - Rotary switch, S3, selects any range of pulse delay.

D FINE DELAY CONTROL - Potentiometer, R16, is the vernier control of pulse delay through each delay range.

E WIDTH RANGE SWITCH - Rotary switch, S4, selects any range of pulse width.

F FINE WIDTH CONTROL - Potentiometer, R32, is the vernier control of pulse width through each width range.

G AMPLITUDE CONTROL - Potentiometer, R25, varies pulse amplitude from zero to full amplitude.

H EXT TRIG JACK - Coaxial connector, J1, couples a trigger pulse from an external source into the trigger amplifier, Q4, when operating in the "external trigger" mode.

I SYNC OUT - Coaxial connector, J2, couples out the unit synchronizing output pulse.

J FUNCTION SWITCH - Rotary switch, S2, selects the unit mode of power operation. It selects "off", "AC" when operating from standard 60 cycle line, "Bat" when operating from the internal battery pack, and "Chg" when re-charging the internal battery pack.

K PILOT LAMP - Lamp, DS1, indicates when the unit is on AC line operation only.

L OVERLOAD INDICATOR - Lamp, DS2, indicates when the unit is being operated in excess of 30% duty factor. It is a warning to the operator that the output pulse amplitude is being automatically reduced.

M POLARITY SWITCH - Rotary switch, S6, selects the polarity of the main output pulse.

N ATTENUATOR SWITCH - Toggle switch, S5, inserts a fixed 20db of attenuation. This should be used for improved pulse shape when operating at low output levels.

O PULSE OUT JACK - Coaxial connector, J3, couples out the main output pulse.

PRELIMINARY INSTRUCTIONS

The 30% duty factor limitation is automatically controlled in the model B14. Should the duty factor limitation be exceeded, the model B14 automatically reduces the amplitude of the output pulse to such a level that the ratings of the output transistor are not exceeded. When the duty cycle limiter is in operation, the duty cycle lamp is lit to warn the operator of the reduced pulse amplitude condition.

FIRST TIME OPERATION

The following procedure is recommended for putting the instrument into operation for the first time.

1. Turn the power (Function) switch to "OFF" and connect the line cord to a source of 115 volt, 50-60 cps power.

2. Set the instrument controls as follows:

A.	Repetition Rate Range	200 kc
B.	Repetition Rate	100 kc
C.	Delay Range	1µsec
D.	Delay	0µsec
E.	Width Range	10µsec
F.	Width	1µsec
G.	20db Step Attenuator	0db
H.	Amplitude	cw
I.	Polarity	"+"

3. Connect an oscilloscope as follows:

A.	Sweep	1µsec/cm
B.	Vertical Deflection	10 volts/cm
C.	Trigger	External from the sync out connector on the model B14 front panel.

4. Connect a ground strap from the model B14 to a ground binding post on the oscilloscope.

5. Connect a resistive load between the pulse out connector and ground.

6. Connect the input probe of the oscilloscope across the external load. If the true waveform of the output pulse is to be observed, it is imperative that the oscilloscope input probe be properly compensated for viewing step function waveforms and that the probe ground strap be connected to the instrument chassis ground.

7. Turn the model B14 power switch to "AC". Adjust the trigger sensitivity of the oscilloscope for a stable trace. The model B14 controls may now be set to any desired values, taking into account duty factor considerations.

8. If the model B14 contains the optional battery pack, it may be switched to battery operation by turning the function switch to the "BAT" position.

TECHNICAL DESCRIPTION

The following dissertation describes the technical operation of the model B14 and/or B14R pulse generator. It includes a technical description and the theory of operation of each of the circuits. A careful study of the block and timing diagram (Dwg # B14-A-100) and the schematic diagram (Dwg #B14-A-101) in conjunction with this discussion will aid in a thorough understanding of the generator.

For purposes of simplicity, all components are referred to by their schematic symbol number. The schematic diagram and/or the instruction manual parts list should be consulted to determine the value, tolerance, etc. of specific components.

GENERAL DESCRIPTION

The model B14 consists of five sub-sections; the repetition rate section, the delay section, the width section, the output section, and the power supply.

The repetition rate section creates a basic system timing trigger. The repetition rate of the trigger is pre-determined by the setting of the front panel repetition rate range and vernier controls. This section also contains circuitry for triggering the generator from an external source and for supplying a T_o synchronizing pulse.

The delay section accepts the trigger from the repetition rate section, delays it in time by an amount pre-determined by the front panel delay range and vernier settings, and presents a trigger to the width section. This trigger ultimately forms the leading edge of the output pulse.

The width section creates a waveform which starts in time coincidence with the output trigger of the delay unit and ends after a time which is pre-determined by the setting of the front panel width range and vernier dial.

The output section receives this waveform from the width section, amplifies it, and presents it as the main output pulse. The polarity and amplitude of the main output pulse are also determined by circuitry in the output section.

The power supply section furnishes all of the voltages necessary for the proper operation of the generator.

THE REPETITION RATE SECTION

The repetition rate section consists of an emitter-coupled, free-running multivibrator (Q1 and Q3), a constant current source (Q2), a trigger amplifier (Q4), a sync pulse amplifier (Q5), and their associated circuitry.

For purposes of explanation, assume that the multivibrator is at the very beginning of a normal run-down period. Let us examine the conditions as they exist at this point in time.

1. There is a steady-state current flowing through R1, Q1, R2, and R3. This establishes a steady-state voltage at the base of Q3 which is a few volts negative with respect to the +7.5 volt supply. This also establishes a steady voltage at the base of Q2.

2. A small current is flowing through R6, Q3, and R7.

3. The selected timing capacitor (C2 through C7) is fully charged. The junction of CR1, CR2, and the timing capacitor is at a voltage which is positive with respect to the +7.5 volt supply.

Continuing on in time, the voltage at the junction of CR1, CR2, and the timing capacitor is decreasing linearly with respect to time due to the discharge of the timing capacitor by the constant current source Q2, R4, and R5. At a certain point in time, the voltage at this junction reaches a level where CR1 starts to conduct. Let us stop at this point, just after the start of CR1 conduction, and again examine what is happening.

1. In starting to conduct, CR1 is drawing some of the current which had been flowing through Q1, R2, and R3. This decrease in current flow causes a drop in voltage at the base of Q3.

2. Current flow increases in Q3 which in turn increases the current flow through CR1, further cutting Q1 off. As Q1 is further cut off, the voltage at the base of Q3 drops further, etc.

This action, in a very short time, produces a surge of current through CR2, the timing capacitor, Q3, and R7. This surge recharges the capacitor to a point near its original charge, the final conduction of CR1 returns it to its full original charge, and the cycle begins again.

A positive-going pulse, created by the current surge during recharge time, is coupled from the collector of Q3, through C10, to the trigger amplifier, Q4. Note that in the external trigger mode of operation, the positive external trigger pulse is coupled directly into Q4 through C9 and R56. During this mode of operation, the timing capacitor is removed from the multivibrator by range switch S1, disabling the internal repetition rate section.

Decade ranges of repetition rate are established by the timing capacitors, C2 through C7, which are switched into the circuit by the range switch S1. Vernier control of repetition rate through each range is accomplished

by R4 which varies the constant current source used to discharge the timing capacitor. Potentiometer, R3, sets the low end calibration of all ranges by adjusting the steady-state voltage level at the base of Q2. High end calibration is accomplished by R5. By-pass and de-coupling components such as C1, C8-R63, and C16-R64 help to eliminate jitter and prevent interaction between the multivibrator and other circuitry within the unit.

The remaining circuit in the repetition rate section is the sync pulse amplifier, Q5. The negative-going timing pulse from the collector of Q4 is coupled into the base of Q5 through C12 and DL1. The positive-going sync pulse is coupled to the front panel jack, J2, through C14. Delay line, DL1, delays the synchronizing pulse by approximately 0.2μsec, with respect to the repetition rate section output trigger. This is approximately the time-delay which is inherent in the remainder of the pulse handling circuitry. Thus, we are able to produce the output pulse with a minimum delay of 0.0μsec with respect to the sync pulse.

THE DELAY SECTION

Transistors Q6, Q7, Q8, and Q9 form the delay section of the model B14. In the normal, steady-state condition Q8 is conducting, its base being held approximately one volt less positive than the base of Q7 by the CR8, CR9, and R23 combination. Q6 and Q7 are cut off, and Q9 is conducting.

When the negative-going trigger pulse from Q4 appears at the base of Q6 its collector goes momentarily positive, cutting off Q9. The emitter of Q9 goes a few volts positive and the current through R27 and R54 flows through the selected timing capacitor (C17 through C22). This flips the base of Q8 positive, which cuts Q8 off. Q7 picks up the current through R19, which in turn raises the voltage at the base of Q9 to an amount determined by the settings of R16 and R17.

The current through R27 and R54 continues to charge the timing capacitor and hold Q8 cut-off until the voltage at the junction of R27 and the timing capacitor reaches a value corresponding to the voltage set on the base of Q9. When this occurs, Q9 begins to conduct again, the base voltage of Q8 drops, allowing it to conduct again, Q7 cuts off and the circuit has returned to its normal steady-state condition. It will remain in this condition until the advent of another trigger pulse from the repetition rate section.

The trailing edge of the waveform at the collector of Q8 is differentiated and coupled through pulse transformer T2 to trigger the width section.

Thus, we have created a trigger pulse which is delayed in time with respect to the initiating trigger.

Decade ranges of delay are established by the timing capacitors, C17 through C22, which are switched into the circuit by range switch S3. Vernier control of delay through each range is accomplished by R16 which establishes the point in time that Q9 starts to conduct by setting the voltage level at the base of Q9. Potentiometer, R17, sets the low end calibration of all ranges by fixing a minimum voltage to which the base of Q9 may be set. High end calibration is accomplished by R27. By-pass and de-coupling components such as C41-R65, C43-R66, and C47-R57 help to eliminate jitter and prevent interaction between the delay circuit and other circuitry within the unit. Diode CR10 provides protection for the emitter-base junction of Q9.

THE PULSE WIDTH SECTION

With the exception of the type of waveform coupled out, the width section operates in exactly the same manner as the delay section.

Transistors Q11, Q12, Q13, and Q14 form the pulse width section of the model B14. In the normal, steady-state condition Q13 is conducting, its base being held approximately one volt less positive than the base of Q12 by the CR13, CR14, and R38 combination. Q11 and Q12 are cut off, and Q14 is conducting.

When the negative-going trigger pulse from T2 appears at the base of Q11 its collector goes momentarily positive, cutting off Q14. The emitter of Q14 goes a few volts positive and the current through R39 and R55 flows through the selected timing capacitor (C28 through C33). This flips the base of Q13 positive, which cuts Q13 off. Q12 picks up the current through R34, which in turn raises the voltage at the base of Q14 to an amount determined by the settings of R32 and R33.

The current through R39 and R55 continues to charge the timing capacitor and hold Q13 cut off until the voltage at the junction of R39 and the timing capacitor reaches a value corresponding to the voltage set on the base of Q14. When this occurs, Q14 begins to conduct again, the base voltage of Q13 drops, allowing it to conduct again, Q12 cuts off and the circuit has returned to its normal steady-state condition. It will remain in this condition until the advent of another trigger pulse from the delay section.

The waveform at the collector of Q13, which is a negative-going pulse starting in time coincidence with the trigger from the delay unit and equal in duration to the desired pulse width, is coupled through R37 and C26 to the pulse forming section.

Decade ranges of width are established by the timing capacitors, C28 through C33, which are switched into the circuit by range switch S4. Vernier control of width through each range is accomplished by R32 which establishes the point in time that Q14 starts to conduct by setting the voltage level of the base of Q14. Potentiometer, R33, sets the low end calibration of all ranges by fixing a minimum voltage to which the base of Q14 may be set. High end calibration is accomplished by R39. By-pass and de-coupling components such as C44-R67, C46-R68, and C48-R58 help to eliminate jitter and prevent interaction between the delay circuit and other circuitry within the

unit. Diode CR15 provides protection for the emitter-base junction of Q14.

THE OUTPUT SECTION

The output circuit consists of Q15, Q16, Q17, Q18, and their associated circuitry. Q15, Q16, and Q17 are three stages of RC coupled amplifiers.

Q15 is normally conducting. The negative-going pulse width waveform drives it out of conduction. The positive pulse output of Q15 is shaped and amplified by Q16. The output of Q16 is coupled through a shaping network, R43-C35, to Q17. The positive output from Q17 is further shaped by R49, R60, and C36 and is coupled to Q18. For a positive output pulse, R50 is switched into the base drive circuit of Q18.

Depending on the position of polarity switch S6, the output transistor, Q18, is connected as an emitter-follower (positive output pulse) or as a normal inverting amplifier (negative output pulse).

The power supply for transistors Q16, Q17, and Q18 is variable from zero to approximately +20 volts. This is controlled by the output amplitude control, R25. The T-section attenuator pad (S5, R45, R46, and R47) is a 20db attenuator which provides improved pulse shape at very low output levels.

C35, C36, and C51 are pulse shape controls. Diodes CR16, CR17, CR18, CR20, and CR21 and resistor R53 are protective devices which serve the purpose of protecting the output section transistors from injury due to spikes kicked back from externally connected lines, etc. L1 is a peaking choke which sharpens the leading edge of the output pulse.

THE POWER SUPPLY SECTION

The power supply section supplies two zener (CR7) regulated voltages, +7.5 and +15 volts (referenced to internal ground) and a variable zero to +20 volt supply. These voltages are derived from a bridge rectifier (CR3, CR4, CR5, and CR6) on the secondary of the input power transformer, T1.

Potentiometer R25 adjusts the base drive to Q10 to control the variable voltage. Emitter-follower Q10 controls voltage over a wide range, giving pulse amplitude control from zero to full amplitude. Diode CR19 provides a bias for holding Q17 off.

The overload lamp, DS2, is an indication to the operator that the unit is operating in excess of 30% duty factor and that the output pulse amplitude is being reduced.

When the polarity switch is in the positive position, the internal ground of the generator is connected to chassis ground. In the negative position, the variable +20 volts is connected to chassis ground. Never physically connect the internal ground to chassis ground, as damage to the power supply will result.

MAINTENANCE

The following suggestions are designed to aid the maintenance technician in scheduling regular preventative as well as corrective maintenance routines. It is important that maintenance routines be performed regularly in order to obtain maximum life and usefullness from the instrument.

Although the transistorized model B14 should give years of trouble-free operation, it is important that normal inspection and cleaning routines be observed.

At regular intervals, any dust which may have settled on the interior of the instrument should be removed by means of dry compressed air. Avoid the use of high velocity air streams which might injure delicate components or disturb adjustments. Persistent dirt may be removed with a lint-free cloth and, if necessary, corbon tetrachloride.

While cleaning the interior of the instrument, inspect the rotary switches for proper centering of the contacts in each index position. Improperly centered contacts may result if the switch has become warped or twisted. Avoid excessive pressure on these contacts, as they are easily damaged. If the silver plated contacts of the rotary switches have become tarnished due to non-use, they may be cleaned by rotating the switch through all of its positions several times.

CALIBRATION

The model B14 contains nine (9) calibration controls and three (3) pulse shape adjustments, all of which are easily found when the covers are removed.

REPETITION RATE

To calibrate repetition rate, set the rep rate range switch, S1, to the 200kc range. Set the fine rep rate control, R4, to the low end (ccw) vernier mark. Adjust R3 (LO REP RATE ADJ on the bottom of the circuit board) for a 20kc rep rate. Reset R4 to the high end (cw) vernier mark and adjust R5 (HI REP RATE ADJ on the bottom of the circuit board) for a 200kc rep rate. Repeat this process several times as there is a certain amount of inter-action between the two controls. Switch S1 to the 2mc range. Set R4 to the high end

(cw) vernier mark. Adjust C2 (on the rep rate range switch) until the output pulse is operating at exactly 2mc (0.5µsec, pulse to pulse).

DELAY

To calibrate delay, set the delay range switch, S3, to the 10µsec range. Set the fine delay control, R16, to the high end (cw) vernier mark and adjust R27 (HI DEL ADJ on the bottom of the circuit board) for 10µsec delay, referrenced to the sync pulse output. NOTE: The low delay adjustment, R17, is a very critical adjustment which is pre-set and sealed at the factory. It is strongly recommended that this adjustment not be readjusted in the field. Switch S3 to the 1µsec range. Set R16 to the high end (cw) vernier mark. Adjust C17 (on the delay range switch) until the leading edge of the output pulse is delayed by exactly 1µsec from the leading edge of the sync pulse output.

WIDTH

To calibrate pulse width, set the width range switch, S4, to the 10µsec range. Set the fine width control, R32, to the high end (cw) vernier mark and adjust R39 (HI WID ADJ on the bottom of the circuit board) for 10 µsecs pulse width, measured at 50% amplitude points. NOTE: The low width adjustment, R33, is a very critical adjustment which is pre-set and sealed at the factory. It is strongly recommended that this adjustment not be readjusted in the field. Switch S4 to the 1µsec range. Set R32 to the high end (cw) vernier mark. Adjust C28 (on the width range switch) until the pulse width is exactly 1µsec.

PULSE SHAPE

C35 and C36 (on the top of the circuit board) and C51 (between S5 and S6) are pulse shape adjustments. It is recommended that a sampling oscilloscope be used in adjusting pulse shape, as the vertical amplifiers of a slower type oscilloscope degrade the pulse rise time to the extent that it is nearly impossible to make proper adjustments.

Open C51 to its minimum capacity. Set pulse width to minimum, polarity to "+", and amplitude to full output (cw). Adjust C35 for minimum output pulse width, being careful not to introduce undershoot. Switch to negative output. Adjust C36 for optimum pulse shape, being careful not to introduce undershoot. Repeat the adjustment of C35 and C36 several times as there is a certain amount of inter-action between the two controls. Finally, adjust C51 for fastest risetime, being careful not to introduce overshoot.

Introduce approximately 20db of attenuation with the amplitude control and recheck all parameters making slight readjustments if necessary.

TROUBLE SHOOTING

The following trouble shooting suggestions are offered as being the most logical, step-by-step method of quickly ascertaining the reason for failure. This method assumes that there are no outputs from the generator in any mode of operation.

Step #1 Check the input line voltage to ascertain that it is being delivered properly to the B14 input connector. If good, proceed to step #2.

Step #2 Check all operating controls for proper setting. Specifically check that the delay or pulse width settings do not exceed approximately 80% of the pulse to pulse spacing, that the amplitude control is in the clockwise position, that the attenuator toggle switch is in the 0db position, and that the function switch is in the AC position. If good, proceed to step #3.

Step #3 Check the line fuse on the rear of the instrument. If blown, proceed to step #4. If good, replace and proceed to step #5.

Step #4 Check for shorted T1, CR3 through CR6, or a voltage supply line shorted to internal or chassis ground.

Step #5 With the polarity switch in the "+" position, check the +15V., +7.5V., and variable 0 to +20 volt supply lines. In the "+" polarity position these may be checked against chassis ground. The 0 to +20 volt variable supply may be varied with the amplitude control. If voltages are in error, proceed to step #6. If they are good, proceed to step #7.

Step #6 If the +15 and +7.5V. supplies are bad, check the circuitry of zener diode CR7. If the variable supply is bad check the circuitry of emitter-follower, Q10.

Step #7 Check for a sync pulse out at J2. If it is not there, proceed to step #8. If it is present, proceed to step #9.

Step #8 Check for a negative-going pulse at the base of Q5. If it is there, replace Q5. If it is not there check for a positive pulse at the base of Q4. If it is there, replace Q4. If it is not there check the circuitry associated with the rep rate multivibrator; C1, Q2, and Q3. Refer to the technical section of this manual for a complete description of the proper operation of this circuit.

Step #9 Sync the oscilloscope with the sync pulse and check for a positive-going pulse at the base of Q18. If it is present, check Q18 and the circuitry associated with

S5 and S6. If it is not there, proceed to step #10.

Step #10 Check for a negative-going pulse at the base of Q17. If it is there, replace Q17. If it is not there, proceed to step #11.

Step #11 Check for a positive-going pulse at the base of Q16. If it is there, replace Q16. If not, proceed to step #12.

Step #12 Check for a negative-going pulse at the base of Q15. If it is there, replace Q15. If not, proceed to step #13.

Step #13 Check for a negative-going spike at the base of Q11. If it is present, check the circuitry of the width multivibrator; Q11, Q12, Q13 and Q14. Refer to the technical section of this manual for a complete description of the proper operation of this circuit. If there is no pulse at the base of Q11, proceed to step #14.

Step #14 Check for a negative-going spike at the base of Q6. If it is there, and it should be since there is a sync pulse, check the circuitry of the delay multivibrator; Q6, Q7, Q8, and Q9. Refer to the technical section of this manual for a complete description of the proper operation of this circuit.

PARTS LIST

This parts list contains identifying information on all of the replaceable parts contained in the model B14 and/or B14R. These parts are listed in alpha-numerical order by schematic symbol number. Items #B14-67 through B14-86 have no schematic symbol number, but are considered to be replaceable parts.

The column headed "ITEM #" is the component identifying number assigned by the RUTHERFORD ELECTRONICS CO.

The column headed "SYMBOL #" designates the component as it is found on the schematic diagram, Dwg. # B14-A-101.

The column headed "DESCRIPTION" is, in general, a full electrical description of the component.

The column headed "SUGGESTED VENDOR" is merely an indication of one source from which the component is available. In filling any order for spare parts, the RUTHERFORD ELECTRONICS CO. reserves the right to make SUBSTITUTIONS, for any component listed in this list, with a component from a different vendor, or the same vendor, if we deem the new component to perform satisfactorily in the instrument.

The column headed "VENDOR PART NO." is the part number assigned to the component by the vendor listed in the previous column. In cases where no part no. is given, the component should be ordered by its description.

The column headed "SUGGESTED UNIT PRICE" gives only an indication of the probable cost for a single unit of the component or assembly listed, if purchased from the RUTHERFORD ELECTRONICS CO. It is not, in any case, to be construed as a firm price quotation. Any customer wishing to purchase a complete or partial set of spare parts should enter a request for quotation of price and delivery to the RUTHERFORD ELECTRONICS CO. or their authorized representatives.

The column headed "SUGGESTED SPARES" lists the quantity of each of the items which the manufacturer recommends as spares for one (1) years operation.

When ordering a complete or partial set of spares, specify by listing all of the information contained in this list for that particular part. The more descriptive information given on a parts order, the less chance there is for expensive and time consuming error.

Minimum parts order billing is $7.50. Prices are subject to change without notice.

ABBREVIATIONS

cer	ceramic	k	kilohm or 10^3 ohms	prec	precision
comp	composition	m	milli or 10^{-3}	PT	paper tubular
EMC	electrolytic, metal cased	meg	megohm or 10^6 ohms	SM	silvered mica
EMT	electrolytic, metal tubular	MF	metal film	V	working volts, DC
f	farad	μ	micro or 10^{-6}	var	variable
GMV	guaranteed minimum value	$\mu\mu$	micromicro or 10^{-12}	W	watt
h	henry	Ω	ohm	WW	wire wound

ITEM NO.	SYMBOL NO.	DESCRIPTION	SUGGESTED VENDOR	VENDOR PART NO.		SUGGESTED UNIT PRICE	SUGGESTED SPARES
B14-1	B1	BATTERY PACK	RUTHERFORD	J046		$ 75.00	1
B14-2	C1	CAPACITOR, fixed, cer, 0.01µf, 500V, GMV	Various			.15	1
B14-3	C2	CAPACITOR, var, mica, 9-180µµf, 175V	ARCO	463		.50	2
B14-4	C3	CAPACITOR, fixed, SM, 330µµf, 500V, ±5%	Various			.43	2
B14-5	C4	CAPACITOR, fixed, SM, 4700µµf, 500V, ±1%	Various			1.22	1
B14-6	C5	CAPACITOR, fixed, mylar, 0.047µf, 150V, ±1%	Various			2.28	1
B14-7	C6	CAPACITOR, fixed, mylar, 0.47µf, 150V, ±1%	Various			2.25	1
B14-8	C7	CAPACITOR, fixed, mylar, 4.7µf, 150V, ±1%	Various			9.20	1
B14-9	C8	CAPACITOR, fixed, cer, 0.1µf, 50V, -20+80%	Various			.35	5
B14-10	C9	CAPACITOR, fixed, cer, 0.001µf, 500V, GMV	Various			.15	1
B14-11	C10	CAPACITOR, fixed, SM, 150µµf, 500V, ±5%	Various			.43	1
	C11	See B14-11					
	C12	See B14-11					
B14-12	C13	CAPACITOR, fixed, SM, 180µµf, 500V, ±5%	Various			.43	1
	C14	See B14-2					
B14-13	C15	CAPACITOR, fixed, EMC, 1500µf, 50V, -10+50%	Sangamo	PLPS-064		4.00	1
	C16	See B14-9					
	C17	See B14-3					
	C18	See B14-4					
	C19	See B14-5					
	C20	See B14-6					
	C21	See B14-7					
	C22	See B14-8					
B14-14	C23	CAPACITOR, fixed, EMT, 500µf, 25V, -10+50%	Various			2.30	1
	C24	See B14-12					
	C25	See B14-13					
	C26	See B14-4					
	C27	See B14-9					
	C28	See B14-3					
	C29	See B14-4					
	C30	See B14-5					
	C31	See B14-6					
	C32	See B14-7					
	C33	See B14-8					
	C34	See B14-2					
	C35	See B14-3					
	C36	See B14-3					
	C37	See B14-14					
	C38	See B14-9					
	C39	See B14-9					
	C40	See B14-9					
	C41	See B14-9					
	C42	See B14-9					
	C43	See B14-9					
	C44	See B14-9					
B14-15	C45	CAPACITOR, fixed, EMC, 2,000µf, 25V, -10+50%	Various			3.20	1
	C46	See B14-9					
	C47	See B14-9					
	C48	See B14-9					
	C49	Not Assigned					
	C50	See B14-9					
	C51	See B14-3					

ITEM NO.	SYMBOL NO.	DESCRIPTION	SUGGESTED VENDOR	VENDOR PART NO.		SUGGESTED UNIT PRICE	SUGGESTED SPARES
B14-16	CR1	DIODE, germanium	HUGHES PRODUCTS	1N116		$ 1.50	4
	CR2	See B14-16					
B14-17	CR3	DIODE, silicon, 750ma, ~~400PIV~~ 160	SEM-TECH	SC-~~4~~		1.10	4
	CR4	See B14-17					
	CR5	See B14-17					
	CR6	See B14-17					
B14-18	CR7	DIODE, zener	INT. RECT.	1N1606		7.75	1
	CR8	See B14-16					
	CR9	See B14-16					
B14-19	CR10	DIODE, germanium	Various	1N774		.82	5
	CR11	See B14-17					
	CR12	See B14-19					
	CR13	See B14-16					
	CR14	See B14-16					
	CR15	See B14-19					
	CR16	See B14-19					
	CR17	See B14-19					
	CR18	See B14-19					
	CR19	See B14-17					
	CR20	See B14-19					
	CR21	See B14-19					
B14-20	DL1	DELAY LINE, fixed, 0.2μsec, 1,000Ω	RUTHERFORD	SD-A-215		8.50	1
B14-21	DS1	LAMP, indicator	GEN. ELECT	#47		.15	1
B14-22	DS2	LAMP, indicator	GEN. ELECT	#44		.15	1
B14-23	F1	FUSE, type 3AG, 0.5 amp	Various			.18	5
B14-24	J1	CONNECTOR, coax, UG-657/U, type BNC	AMPHENOL	31-102		1.88	1
	J2	See B14-24					
	J3	See B14-24					
B14-25	L1	COIL, fixed, 0.47μH, ±20%	RUTHERFORD	201-11		.75	1
B14-26	P1	CORD, power, w/plug, 3 wire	RUTHERFORD	SD-B-143		1.12	1
B14-27	Q1	TRANSISTOR, germanium	MOTOROLA	2N967		1.95	12
B14-28	Q2	TRANSISTOR, silicon	MOTOROLA	2N706		4.74	3
	Q3	See B14-27					
	Q4	See B14-27					
	Q5	See B14-27					
	Q6	See B14-27					
	Q7	See B14-27					
	Q8	See B14-27					
	Q9	See B14-27					
B14-29	Q10	TRANSISTOR, silicon	SYLVANIA	SYL1674 or 2N1218		8.25	1
	Q11	See B14-27					
	Q12	See B14-27					
	Q13	See B14-27					

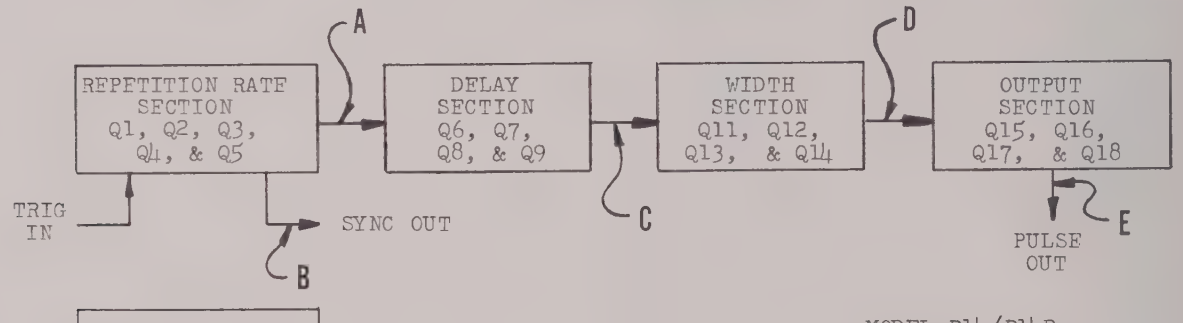
ITEM NO.	SYMBOL NO.	DESCRIPTION	SUGGESTED VENDOR	VENDOR PART NO.		SUGGESTED UNIT PRICE	SUGGESTED SPARES
	Q14	See B14-27					
	Q15	See B14-28					
	Q16	See B14-28					
B14-30	Q17	TRANSISTOR, germanium	MOTOROLA	2N2381		$ 8.25	1
B14-31	Q18	TRANSISTOR, silicon	MOTOROLA	2N2537		7.65	2
B14-32	R1	RESISTOR, fixed, comp, 1.2k, ½W, ±10%	AL-BRAD	EB1221		.12	1
B14-33	R2	RESISTOR, fixed, comp, 470Ω, ½W, ±10%	AL-BRAD	EB4711		.12	1
B14-34	R3	RESISTOR, var, comp, 1k, 1W, 30%	RUTHERFORD	Spec #		3.00	1
B14-35	R4	RESISTOR, var, comp, 10k, 2W, ±20%	RUTHERFORD	B7B-B-513-4		3.75	1
	R5	See B14-34					
B14-36	R6	RESISTOR, fixed, comp, 2.2k, ½W, ±10%	AL-BRAD	EB2221		.12	1
B14-37	R7	RESISTOR, fixed, comp, 270Ω, ½W, ±10%	AL-BRAD	EB2711		.12	1
B14-38	R8	RESISTOR, fixed, comp, 330Ω, ½W, ±10%	AL-BRAD	EB3311		.12	2
B14-39	R9	RESISTOR, fixed, comp, 4.7k, ½W, ±10%	AL-BRAD	EB4721		.12	1
	R10	See B14-32					
	R11	See B14-33					
B14-40	R12	RESISTOR, fixed, comp, 1k, ½W, ±10%	AL-BRAD	EB1021		.12	2
B14-41	R13	RESISTOR, fixed, comp, 820Ω, ½W, ±10%	AL-BRAD	EB8211		.12	1
B14-42	R14	RESISTOR, fixed, comp, 100Ω, ½W, ±10%	AL-BRAD	EB1011		.12	1
B14-43	R15	RESISTOR, fixed, comp, 180Ω, ½W, ±10%	AL-BRAD	EB1811		.12	1
B14-44	R16	RESISTOR, var, comp, 500Ω, 2W, ±20%	RUTHERFORD	B7B-B-513-1		3.75	1
	R17	See B14-34					
B14-45	R18	RESISTOR, fixed, comp, 47Ω, 2W, ±10%	AL-BRAD	HB4701		.24	1
	R19	See B14-40					
B14-46	R20	RESISTOR, fixed, comp, 150Ω, 2W, ±10%	AL-BRAD	HB1511		.24	1
B14-47	R21	RESISTOR, fixed, comp, 120Ω, 2W, ±10%	AL-BRAD	HB1211		.24	1
	R22	See B14-38					
B14-48	R23	RESISTOR, fixed, comp, 10k, ½W, ±10%	AL-BRAD	EB1031		.12	1
B14-49	R24	RESISTOR, fixed, comp, 39Ω, 2W, ±10%	AL-BRAD	HB3901		.24	1
B14-50	R25	RESISTOR, var, comp, 2.5k, 2W, ±20%	AL-BRAD	JA1N052P252UA		4.04	1
	R26	See B14-38					
B14-51	R27	RESISTOR, var, comp, 5k, 1W, ±30%	RUTHERFORD	Spec #		3.00	1
B14-52	R28	RESISTOR, fixed, comp, 560Ω, ½W, ±10%	AL-BRAD	EB5611		.12	1
	R29	See B14-38					
	R30	See B14-42					
	R31	See B14-42					
	R32	See B14-44					
	R33	See B14-34					
	R34	See B14-40					
	R35	See B14-40					
	R36	See B14-40					
	R37	See B14-32					
	R38	See B14-48					
	R39	See B14-51					
	R40	See B14-40					
	R41	See B14-33					

ITEM NO.	SYMBOL NO.	DESCRIPTION	SUGGESTED VENDOR	VENDOR PART NO.		SUGGESTED UNIT PRICE	SUGGESTED SPARES
	R42	See B14-38					
B14-53	R43	RESISTOR, fixed, comp, 5.6k, ½W, ±10%	AL-BRAD	EB5621		$ .12	1
	R44	See B14-32					
B14-54	R45	RESISTOR, fixed, comp, 39Ω, 1W, ±10%	AL-BRAD	GB3901		.18	1
B14-55	R46	RESISTOR, fixed, comp, 10Ω, ½W, ±10%	AL-BRAD	EB1001		.12	2
	R47	See B14-54					
B14-56	R48	RESISTOR, fixed, comp, 150Ω, ½W, ±10%	AL-BRAD	EB1511		.12	1
	R49	See B14-36					
B14-57	R50	RESISTOR, fixed, comp, 68Ω, ½W, ±10%	AL-BRAD	EB6801		.12	1
	R51	See B14-33					
	R52	See B14-33					
	R53	See B14-54					
	R54	See B14-40					
	R55	See B14-40					
	R56	See B14-38					
B14-58	R57	RESISTOR, fixed, comp, 22Ω, ½W, ±10%	AL-BRAD	EB2201		.12	1
	R58	See B14-58					
	R59	See B14-58					
	R60	See B14-56					
B14-59	R61	RESISTOR, fixed, comp, 47Ω, ½W, ±10%	AL-BRAD	EB4701		.12	1
	R62	See B14-59					
	R63	See B14-55					
	R64	See B14-55					
	R65	See B14-55					
	R66	See B14-55					
	R67	See B14-55					
	R68	See B14-55					
	R69	See B14-37					
B14-60	S1	SWITCH, rotary, Rep rage range	RUTHERFORD	~~B14-C-211~~ B14-B-315		7.26	1
B14-61	S2	SWITCH, rotary, Function	RUTHERFORD	B14-B-314		1.80	1
B14-62	S3	SWITCH, rotary, Delay or width range	RUTHERFORD	B14-B-316		6.33	1
	S4	See B14-62					
B14-63	S5	SWITCH, toggle, DPDT, 20db attenuator	A H & H	81027-CE		1.80	1
B14-64	S6	SWITCH, rotary, Polarity	RUTHERFORD	B14-B-317		2.67	1
B14-65	T1	TRANSFORMER, power	RUTHERFORD	~~TRC-101-D-500~~ B14-B-501		12.50	1
B14-66	T2	TRANSFORMER, pulse	RUTHERFORD	B7-504		7.50	1
B14-67		ADAPTER, power cord 3 wire to 2 wire	LEVITON	5017		.52	1
B14-68		ASSY, switch, delay, w/comps assembled	RUTHERFORD	B14-C-212		25.56	
B14-69		ASSY, switch, polarity, w/comps assembled	RUTHERFORD	B14-B-204		4.25	
B14-70		ASSY, switch, rep rate, w/comps assembled	RUTHERFORD	B14-C-211		27.66	
B14-71		ASSY, switch, width, w/comps assembled	RUTHERFORD	B14-C-212		25.56	
B14-72		BRACKET, cord holding	RUTHERFORD	B14-C-306		3.00	
B14-73		COVERS, B14 top and bottom	RUTHERFORD	B14-D-308		12.85	
B14-74		COVERS, B14R top and bottom	RUTHERFORD	B14-D-311		14.75	
B14-75		HANDLE, instrument	RUTHERFORD	B14-C-307		2.75	
B14-76		HOLDER, fuse	BUSSMAN	HKP		.62	1

ITEM NO.	SYMBOL NO.	DESCRIPTION	SUGGESTED VENDOR	VENDOR PART NO.		SUGGESTED UNIT PRICE	SUGGESTED SPARES
B14-77	———	HOLDER, lamp, clear	DIALCO	810-B-435	———	$ .64	1
B14-78	———	HOLDER, lamp, green	DIALCO	810-B-432	———	.64	1
B14-79	———	KNOB, instrument, Amplitude	KURZ-KASCH	S648-3L	———	.60	1
B14-80	———	KNOB, instrument, Coarse rep rate, delay, or width	RUTHERFORD	SD-B-224	———	.68	1
B14-81	———	KNOB, instrument, Fine rep rate, delay, or width	RUTHERFORD	SD-B-223	———	.96	1
B14-82	———	KNOB, instrument, Function or polarity	KURZ-KASCH	S647-3L	———	.57	1
B14-83	———	MANUAL, instruction	RUTHERFORD	J045	———	5.00	1
B14-84	———	PANEL, front, B14 w/silk screen	RUTHERFORD	B14-D-301	———	9.75	
B14-85	———	PANEL, front, B14R w/silk screen	RUTHERFORD	B14-D-310	———	10.50	
B14-86	———	STOOL, transistor	MOTOROLA	14C51690A02	———	.15	10

TOTAL SUGGESTED PRICE - ONE (1) SET OF SUGGESTED SPARES, W/BATTERY PACK - $ 288.46

TOTAL SUGGESTED PRICE - ONE (1) SET OF SUGGESTED SPARES, WITHOUT BATTERY PACK - $ 213.46

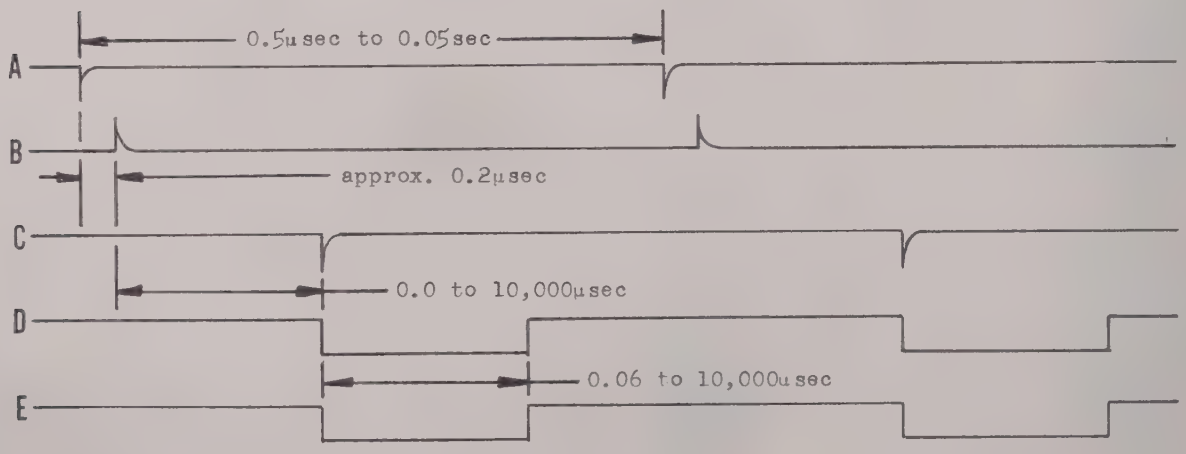


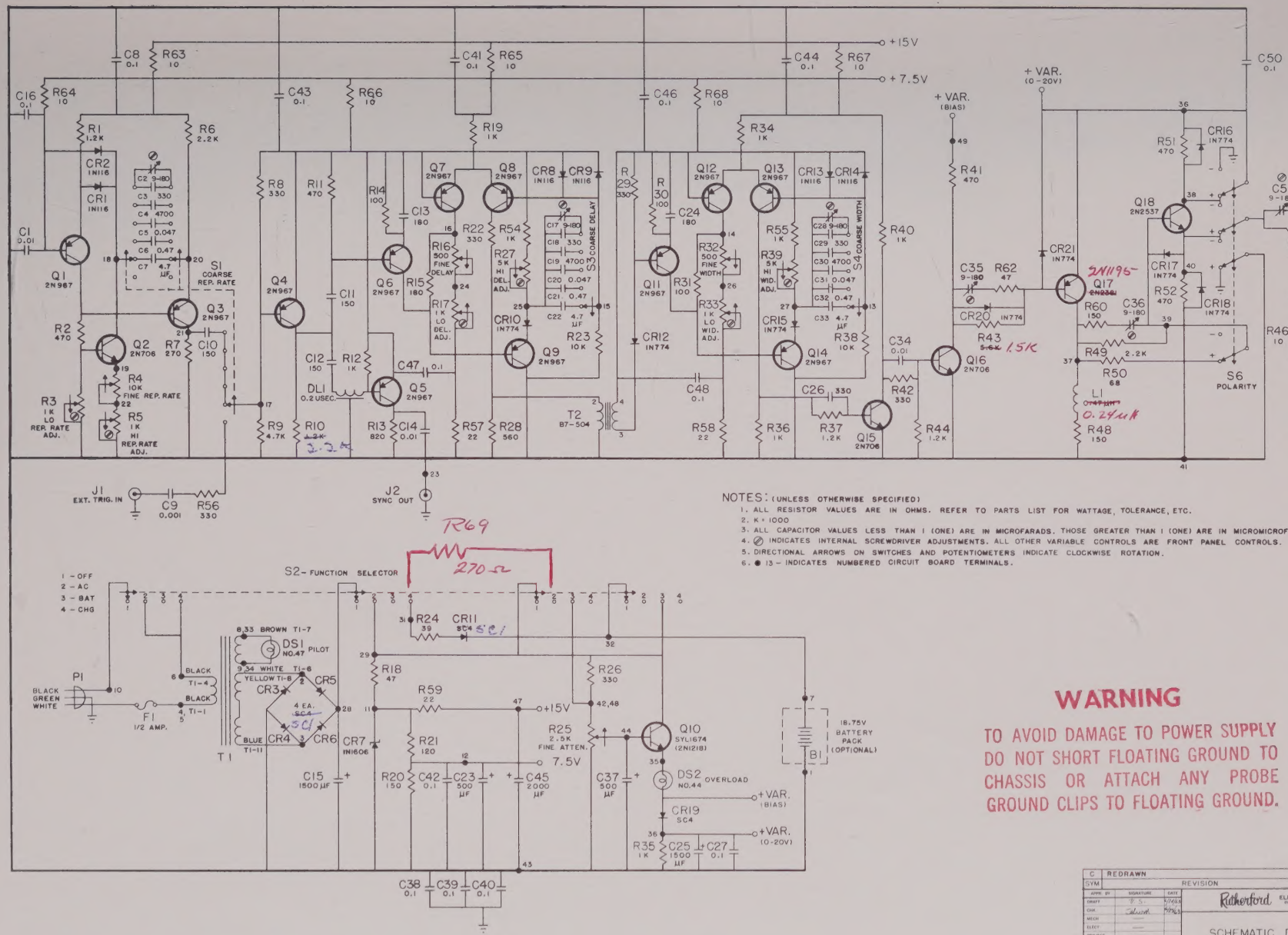
MODEL B14/B14R

System Block & Timing Diagram

from

Dwg. # B14-A-100





NOTES: (UNLESS OTHERWISE SPECIFIED)

1. ALL RESISTOR VALUES ARE IN OHMS. REFER TO PARTS LIST FOR WATTAGE, TOLERANCE, ETC.
2. K = 1000
3. ALL CAPACITOR VALUES LESS THAN 1 (ONE) ARE IN MICROFARADS. THOSE GREATER THAN 1 (ONE) ARE IN MICROMICROFARADS.
4. ⊘ INDICATES INTERNAL SCREWDRIVER ADJUSTMENTS. ALL OTHER VARIABLE CONTROLS ARE FRONT PANEL CONTROLS.
5. DIRECTIONAL ARROWS ON SWITCHES AND POTENTIOMETERS INDICATE CLOCKWISE ROTATION.
6. ● 13 - INDICATES NUMBERED CIRCUIT BOARD TERMINALS.

WARNING

TO AVOID DAMAGE TO POWER SUPPLY DO NOT SHORT FLOATING GROUND TO CHASSIS OR ATTACH ANY PROBE GROUND CLIPS TO FLOATING GROUND.

SYM	REVISION	DATE	APP.
C	REDRAWN	6-24-63	

Rutherford ELECTRONICS CO.

SCHEMATIC DIAGRAM

CODE IDENT. NO.	SIZE	DRAWING NUMBER
89248	A	B14-A-101

SCALE — REF — SHEET 1 OF 1

NOTES

Rutherford ELECTRONICS CO.

1M/763

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